

Astronomy 2115

Fall 2023

Homework #3

Due Thursday, Sep 14 in class

For full credit you must write your solutions neatly and include all work. Do not forget the units. Make sure to do all 12 problems.

1) If a red star and a blue star both appear equally bright and both are at the same distance from Earth, which one has the larger radius? Explain how you know.

2) Most of the bright stars in the night sky are giants and supergiants. How can this be, if giants and supergiants make up only 1% of the population of stars?

3) which is more massive, a red main-sequence star or a blue main-sequence star? Which has the larger radius? Explain your answers.

4) Kapteyn's star has a parallax of 0.255 arcsec, a proper motion of 8.67 arcsec/year, and a radial velocity of +246 km/s. (a) What is the star's tangential velocity? (b) What is the star's actual speed relative to the Sun? (c) Is Kapteyn's star moving toward the Sun or away from the Sun? Explain.

5) The solar constant, equal to 1370 W/m^2 , is the amount of energy from the Sun falling on 1 square meter of the Earth in 1 second. What would be the distance you would have to go from the Sun to have the solar constant be 1 W/m^2 ?

6) The star Procyon in Canis Minor is a prominent star in the winter sky with an apparent brightness 1.3×10^{-11} that of the Sun. It is also one of the nearest stars, only 3.5 pc from Earth. What is the luminosity of Procyon in solar luminosities?

7) The bright star Rigel in the constellation Orion has a surface temperature of about 1.6 times greater than the Sun's photosphere. Rigel's luminosity is $64,000 L_{\text{sun}}$. What is Rigel's radius in solar radii (R_{sun})?

8) Suppose a star experiences an outburst in which its surface temperature doubles but its average density decreases by a factor of 8. The mass of the star stays the same. By what factors do the star's radius and luminosity change?

9) The star HD 3651 has a mass of $0.79 M_{\text{sun}}$. Its brown dwarf companion, HD 3651B, has about 40 times the mass of Jupiter. The average distance between the two stars is 480 AU. How many years does it take the two stars to complete one orbit around each other?

10) The visual binary 70 Ophiuchi has a period of 87.7 years. The parallax of 70 Oph is 0.2 arcsec, and the apparent length of the semimajor axis as seen through a telescope is 4.5 arcsec. (a) What is the distance to 70 Oph in parsecs? (b) What is the actual length of the semimajor axis in AU? (c) What is the sum of the masses of the two stars in solar masses?

11) The interior of a dark nebula is billions of times less dense than the air you breathe. How, then, are the dark nebulae able to block out starlight?

12) What happens inside a protostar that slows and eventually halts its gravitational contraction?